The Great Equatorial Current of Jupiter.
By A. Stanley Williams.

I. *On the Rate of Rotation in* 1897.

Observations were made here last spring with the object of determining the present rate of rotation of the great equatorial current of *Jupiter*. Valuable observations were also received from the undermentioned observers, and have been of great assistance in this research—namely, Messrs. E. M. Antoniadi, Juvisy; L. Brenner, Lussinpiccolo; H. F. Griffiths, Streatham; H. MacEwen, Glasgow; W. H. Maw, South Kensington; T. E. R. Phillips, Yeovil. So that, although the weather proved exceptionally unfavourable, eight spots situated on the north side of the south equatorial belt were observed sufficiently well to enable good determinations of the rotation period to be derived. The observations of these spots are given further on.

In all work of this kind it is of the utmost importance that there should be no possibility of doubt concerning the identity of the markings observed. It is very desirable, therefore, that observers, when stating the results of their investigations, should publish also the observations upon which these results are based; and this is even more important when such results differ materially from those of earlier investigators. In the present instance I have been careful not to include any doubtful cases, and the observations are so numerous, so distributed, and so accordant, that it seems impossible that there can be any doubt as to identity. Most of the columns in the following tables explain themselves. The third column gives the weight attributed to the observation at the time on a scale ranging from 1 (bad) to 5 (good).* The rotation periods have been computed from certain selected observations, and these weights are useful in selecting the best observations, but they have not been made use of in any other way in the calculations. The residuals in the fifth column will show how far the observations are satisfied by the adopted period of rotation in the case of each spot. The longitudes in column 4 are according to "System I" of the late Mr. Marth's Ephemeris. The last column contains the initials of the observer.†

* For the meaning of "est." = estimated transit in connection with an observation by Mr. MacEwen, see *Journal B.A.A.* vol. vii. p. 271; and in connection with an observation by the writer, see *Monthly Notices*, vol. liv. p. 298.

† Most of the transits of equatorial spots by Mr. Gledhill, published in the Supplementary Number of the *Monthly Notices*, refer to spots on the N. equatorial belt. An observation of the dark spot *b* on May 9 has, however, been added in its proper place. A small *bright* spot on the N. edge of his belt 3 is stated to have been on the central meridian, at $8^h 27^m$, on April 28. This would give a position close to the *dark* spot *c*, so that belt 3 is probably a misprint for 5.

White Spot a.

Date	G.M.T. of Transit.	Wt.	Longitude.	O–C.	Observer.
1897	h m		°	m	
Feb. 18	9 40·9	...	39·0	+ 3·7	L. B.
25	8 54·8	...	37·1	– 1·5	,,
Mar. 6	9 27	3	38·8	– 1·4	A. S. W.
8	10 40·3	3	39·6	– 0·8	,,
10	11 57·7	2	42·9	+ 4·0	,,
19	12 27·1	2	42·4	+ 0·5	,,
Apr. 3	6 44·6	...	42·6	– 3·8	L. B.
9	10 40	est.	(53·5)	(+12·1)	H. M.
25	10 24	2	49·3	+ 0·3	A. S. W.
30	8 38·6	...	54·1	+ 6·7	L. B.
May 9	9 4·4	...	50·0	– 2·9	,,
9	9 4·5	2	50·0	– 2·8	A. S. W.

Dark Spot b.

Date	G.M.T. of Transit.	Wt.	Longitude.	O–C.	Observer.
Feb. 11	10 44	4	(51·1)	(+ 6·5)	H. M.
27	10 35·9	...	(54·7)	(+ 6·8)	T. E. R. P.
Mar. 6	9 53	3	(54·7)	(+ 4·2)	A. S. W.
8	11 0·8	4	52·1	– 0·8	,,
10	12 14·7	3	53·3	+ 0·5	,,
Apr. 25	10 47	est.	63·3	+ 0·7	,,
30	8 55	3	64·1	+ 0·3	,,
May 9	9 30	2	65·6	– 0·5	,,
9	9 19	...	(58·9)	(–11·5)	J. G.

Dark Spot c.

Date	G.M.T. of Transit.	Wt.	Longitude.	O–C.	Observer.
Feb. 23	9 13	est.	92·1	+ 1·5	A. S. W.
Mar. 1	12 45·9	...	90·0	– 2·1	T. E. R. P.
6	10 54	3	91·9	+ 0·7	A. S. W.
8	12 4·3	3	90·8	– 1·2	,,
Apr. 7	10 34·7	est.	94·4	+ 3·6	,,
14	9 47	1	90·5	– 3·2	,,
30	9 42	2	92·8	– 0·1	,,
May 14	8 23	3	93·6	+ 0·7	,,

White Spot d.

Date	G.M.T. of Transit.	Wt.	Longitude.	O—C.	Observer.
1897	h m		°	m	
Jan. 17	11 52	1	101·8	+ 3·1	H. M.
Feb. 23	9 29	3	101·9	− 1·6	A. S. W.
Mar. 6	11 14	2	104·1	+ 0·6	,,
8	12 25·3	1	103·6	− 0·5	,,
Apr. 7	10 55·7	2	107·2	+ 1·6	,,
14	10 10	2	104·5	− 3·8	,,
30	9 57·4 (?)	...	(102·2)	(− 9·7)	L. B.
May 14	8 49	1	109·4	+ 0·4	A. S. W.

Dark Spot e.

Date	G.M.T. of Transit.	Wt.	Longitude.	O—C.	Observer.
Jan. 17	12 0	2	106·7	− 0·1	H. M.
Apr. 28	9 21·2 ±	...	124·4	+ 3·2	A. S. W.
May 5	8 38·7	est.	123·2	− 0·6	,,
14	9 15	2	125·3	+ 0·7	,,

White Spot f.

Date	G.M.T. of Transit.	Wt.	Longitude.	O—C.	Observer.
Apr. 10	10 48·5	2	216·5	− 3·4	A. S. W.
24	9 36	2	222·2	+ 3·9	,,
May 3	10 4·8	est.	220·1	− 0·9	,,
June 25	8 3·3	...	225·7	+ 0·6	L. B.

Dark Spot g.

Date	G.M.T. of Transit.	Wt.	Longitude.	O—C.	Observer.
Feb. 3	(13 8)	2	(314·6)	(− 7·3)	H. M.
Mar. 19	10 15·1	2	321·9	− 1·2	A. S. W.
Apr. 27	9 18·2	2	324·9	− 1·5	,,
May 4	8 43·3	est.	328·2	+ 3·0	,,
6	9 55·8	est.	328·0	+ 2·4	,,
13	9 12·5	1	326·0	− 1·8	,,
20	8 34·5	2	327·2	− 0·8	,,

Dark Spot h.

Date	G.M.T. of Transit.	Wt.	Longitude.	O—C.	Observer.
Feb. 3	14 0	est.	346·3	− 1·1	H. M.
Apr. 25	8 49	3	351·5	− 3·1	A. S. W.
27	10 11·2	1	357·2	+ 6·0	,,
May 4	9 23·3	2	352·6	− 2·4	,,
13	9 57·5	1	353·5	− 2·1	,,
15	11 15·5	1	356·5	+ 2·6	,,

Notes.

Spot b. The rot. per. depends upon the observations from Mar. 8 to May 9. On Mar. 6 the spot appeared as a close double spot, a smaller companion lying just following. The time given is that of this double spot considered as

one mass. The observations of Feb. 11 and 27 also evidently relate to the same phase. The later ones refer to the preceding component.

Spot g. This spot was on the north side of the S. Equat. Belt. The observation of Feb. 3 refers to a dark streak on the south edge of the same belt. It is doubtful, therefore, how far this observation relates to Spot *g*, if it does so at all.

Spot h. On April 27 the spot was double and observed as one mass. The last observation was made with a $2\frac{3}{4}$-inch refractor. The transits observed by Mr. Phillips being uniformly earlier than those by the writer, the times given here are the observed times $+ 5^{m}\cdot 9$, the average amount of the difference (from four comparisons).

The following are the adopted periods of rotation, together with the number of rotations elapsed between the first and last observations on which each period is based.

Spot.	Per. of Rotation. h m s	No. of Rotations.	Spot.	Per. of Rotation. h m s	No. of Rotations.
a	9 50 37·6	156	*e*	9 50 36·3	285
b	38·7	151	*f*	33·6	185
c	31·0	195	*g*	33·3	151
d	33·2	285	*h*	33·2	241

Mean $= 9^{h}\ 50^{m}\ 34^{s}\cdot 6$ (8 spots).

The mean period of rotation of the equatorial current in 1897 was therefore $9^{h}\ 50^{m}\ 34^{s}\cdot 6$. This relates to the southernmost portion of the current, to which nearly all previous determinations also refer. The above eight spots were all situated on the north side of the south equatorial belt.*

II. *On the Change in the Rate of Rotation of the Equatorial Current.*

One of the most remarkable facts known in connection with the physical condition of the planet *Jupiter* is the continual decrease in the velocity of the equatorial current since 1879. A list of the different determinations of the period of rotation of this current will be found in the *Monthly Notices*, vol. lvi. p. 147. In order to reduce these into a more manageable form, each result has been given an arbitrary weight. Generally, each determination of the rotation period of a spot has been given weight 1, but a less weight has been assigned wherever the interval of time covered by the observations is short, or there are any other circumstances which might affect the accuracy of the result. The average values for each opposition have then been

* Two prominent dark spots on the south edge of the north equatorial belt give the following results:

Dark spot *i* R $= 9^{h}\ 50^{m}\ 32^{s}\cdot 3$ (217 rotations).

" " *k* R $= 9^{h}\ 50^{m}\ 39^{s}\cdot 7$ (156 ").

found from these weighted results,* and are given in the following table:—

Opposition.	Mean Per. of Rot.	Weight.	C – O.
	h s m		s
1879	9 49 59	1	0·0
1880	9 50 5·0	7	–1·8
1881	10·2	2	–3·2
1882	9·7	2	+1·0
1884	12·4	2	+1·7
1885	14·3	1	+2·9
1886	22·9	1	–2·8
1887	22·4	21	+0·3
1888	31·4	3	–6·3
1891	26·4	1	+4·2
1897	34·6	8	–0·1

The above table shows clearly the remarkable and continual increase in the period of rotation since 1879, a period of eighteen years. The total increase in the period of rotation since 1879 is $35^{s}\!\cdot\!6$, and this is equivalent to a decrease of 26 miles (42 kilometres) per hour in the actual velocity of the current. The decrease in velocity, however, clearly takes place at a slower rate now than formerly, as is evident from the preceding table, which shows also that there has been a progressive decrease in the rate of change. The observed changes in the length of the period of the equatorial current are represented well enough by the formula $R = 9^{h}\ 49^{m}\ 59^{s} + t \times (4^{s}\!\cdot\!3 - 0^{s}\!\cdot\!13t)$, where R is the period of rotation and t the interval of time expressed in oppositions of *Jupiter* elapsed since 1879. The residuals C—O have been added in the last column of the foregoing table in order to show how far the observed values are represented by this formula. The increase in the length of the rotation period has apparently now nearly come to an end, and after next year should be succeeded by a decrease, which would mean of course an increase in the actual velocity of the current, though the change at first would be small. It is very desirable, therefore, that the rate of rotation should be re-determined in the next and succeeding apparitions of *Jupiter*. And the importance of basing such determinations on the observations of a number of spots cannot be too strongly insisted upon.

1897 October 18.

* The effect of this mode of combination is to give a relatively high weight to a result based upon a large number of spots.

On the Nature of the Orbit of γ Lupi. By T. J. J. See, A.M., Ph.D. (Berlin).

The brilliant southern binary γ *Lupi* was discovered by Sir John Herschel, at the Cape of Good Hope, 1834 June 9. The measures secured by him during the next four years define the place of the companion at that epoch with considerable precision; and, as might have been predicted from the appearance of this striking system, time has shown that it is in orbital motion. After Herschel's return to England a long period elapsed before it was again resolved by any telescope in the southern hemisphere, though it was frequently examined with instruments at least equal to that employed in the earliest work at the Cape.

Mr. Russell, of Sydney, deserves our special thanks for the records secured by him from 1874 to the present time with his 11½-inch telescope, which under good conditions ought to separate a nearly equal pair like γ *Lupi* at a distance of 0″·4. For, although these records are of a negative character, they possess the highest interest. The fact that Mr. Russell and his assistants examined this object on many occasions prior to 1880, without being able to divide it, long ago made known that it had narrowed up after the time of Herschel. As the Sydney observers are still unable to divide it, the observations recently secured by Mr. Cogshall and the writer with the Lowell 24-inch refractor at Mexico are the first actual measures of the system for sixty years. These data define the present position of the companion with a high degree of precision, and throw an interesting light upon the character of the orbit; and hence I submit herewith the conclusions at which we have arrived. We swept over the star (unaware that it was γ *Lupi*) on the morning of 1897 January 17, and I saw at once that it was double, and indeed divided clearly, though by no means a very easy object even with the great telescope. It was subsequently re-examined on several nights, and no difficulty was experienced in securing good measures; yet when the seeing was deteriorated it became difficult to measure, and thus during our later work this well-known object served as a most trustworthy and convenient index to the state of the atmosphere. Here at Flagstaff, notwithstanding the low altitude of only 14°, the fine seeing afforded by our location has enabled me to divide it on several occasions during the past summer. The following are all the observations to the present time:—